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An evaluation of the effects of various cultural and site treatments upon the ground cover plants of two distinctly different forest types

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Name: Wildlife Habitat Improvement Investigations in the Central Adirondack Mountains

Title: An evaluation of the effects of various cultural and site treatments upon the ground cover plants of two distinctly different forest types

Period Covered: April 1, 1960 through March 31, 1966

Abstract: A study of the effects of combined cultural and site treatments on ground cover plants was conducted on the Archer and Anna Huntington Wildlife Forest Station in the Adirondack Mountains. Study areas were delineated in 1960, and a pre-treatment tally of vegetation made in 1961. The treatments, consisting of combinations of either upper or lower crown removal with burning or scarification of the ground, were effected in 1962 and 1963. The post-treatment tally, done in 1965, indicated that: (1) herbaceous ground cover was reduced tremendously by all treatments involving burning or scarification, being virtually eliminated on the burns; (2) ground cover was increased slightly by treatments involving crown removal and no disturbance of the site; (3) in the northern hardwood forest, tree reproduction (essentially sugar maple) was not effectively changed by any treatment; and, (4) in the hardwood-conifer forest, tree reproduction (mainly yellow birch) was increased greatly by both burning and scarification.

Objectives: (1) To determine the results on ground cover vegetation of various combinations of cultural and site treatments; (2) to compare the variation in response of ground cover plants in the two contrasting forest types; (3) to observe the effects of the combined treatments on tree and shrub reproduction; and, (4) to lay the groundwork for future larger scale studies which might utilize burning and/or scarification as site treatment techniques.

Techniques General: The method employed consisted of: (1) the selection and
Used: preparation of the study areas; (2) pre-treatment tallies of vegetation; (3) execution of cultural and site treatments; (4) post-treatment tallies of vegetation; and (5) summarization and analysis of data.

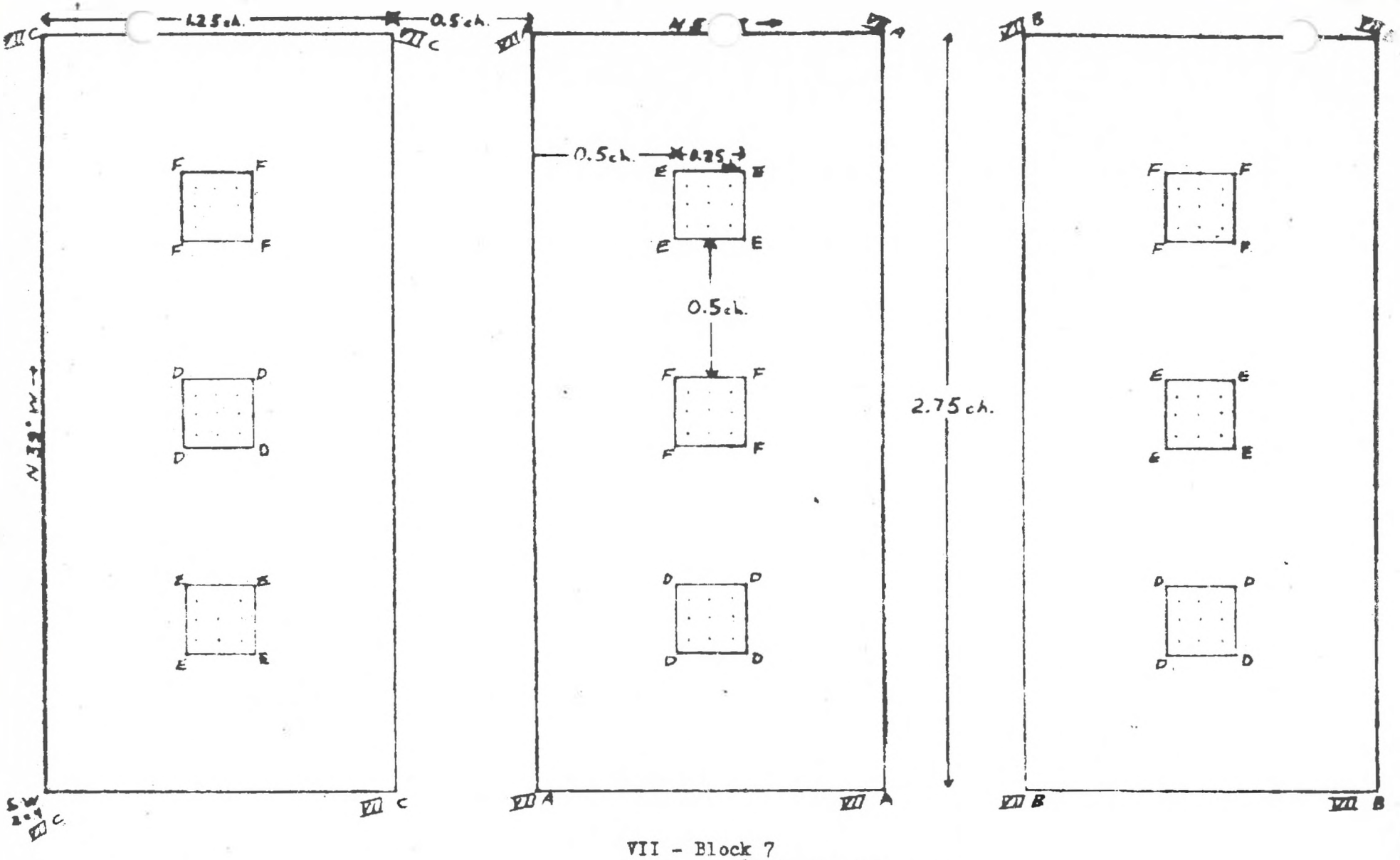
Selection and Preparation of the Study Areas: Eight relatively undisturbed stands on the Archer and Anna Huntington Wildlife Forest Station were chosen for this study. The stands are equally distributed between northern hardwood and hardwood-conifer forest. Within each stand a block of about 1.3 acres was

selected for its conformity to forest type and accessibility. Within each block three plots, 2.75 chains by 1.25 chains, were then established to evaluate the cultural treatments, i.e., upper half of tree crown removed, lower half of tree canopy removed, and control. A one-half chain "buffer" strips separated each plot from the next nearest plots. The corners of each plot were staked and the entire boundary painted blue. A symbol consisting of a Roman numeral and a letter was assigned to each plot, the former to designate the block in which the plot was located, and the latter indicating the cultural treatment to be applied, (A-upper half of crown removed; B-lower half; C-control). Treatments were assigned to the plots on a random basis. Within each cultural treatment plot, three, one-quarter chain square sub-plots were positioned so that each was one-half chain from the plot boundary, and one-half chain from the nearest sub-plot. These sub-plots, to be used for comparison of site treatments, were marked with wooden stakes (for scarification and control treatments), and pieces of bronze rod (for burning treatments). Site treatment were assigned on a random basis and designated by letters (D-burning; E-scarification; F-control). Nine square meter sampling plots were then established within each site treatment sub-plot, and assigned an Arabic numeral. Figure 1 depicts the arrangement of one cultural block.

Pre-treatment Tallies of Vegetation: To facilitate the execution of the cultural treatment, and to make a quantitative measure of the character and composition of the overstory possible, tree crown diagrams were made on the cultural treatment plots as follows: a 100-foot tape was stretched through the center of the plot in a north-south direction, and a six-foot wide belt transect taken along this line. All trees from one-inch d.b.h. up were measured and sketched, with the species, d.b.h. height, crown height and crown width being recorded. Figure 2 depicts a crown profile subjected to the various cultural treatments. On the square meter sampling plots all herbaceous species were counted by stems. In addition all tree reproduction, shrubs and berry canes were tallied by the following height classes: 0-½ foot; ½ foot to 2 feet; 2 feet to 4 feet; 4 feet to 6 feet; 6 feet to 8 feet; 8 feet to 10 feet; and, over 10 feet.

All of the pre-treatment tallies were completed in the summer of 1961.

Execution of Cultural and Site Treatments: Cultural treatment, involving the deadening of vegetation with silvicides, were completed in August, 1961. These treatments were: (1) the deadening of the upper-half of the crown canopy; (2) the deadening of the lower-half of the canopy; and, (3) no treatment-for control. The upper crown treatment was accomplished by the application of sodium arsenite in frill girdles, while the lower half treatment was done by 2-4-5-T applied by mist-blower, and sodium arsenite in frills. These treatments are depicted schematically in Figure 2.



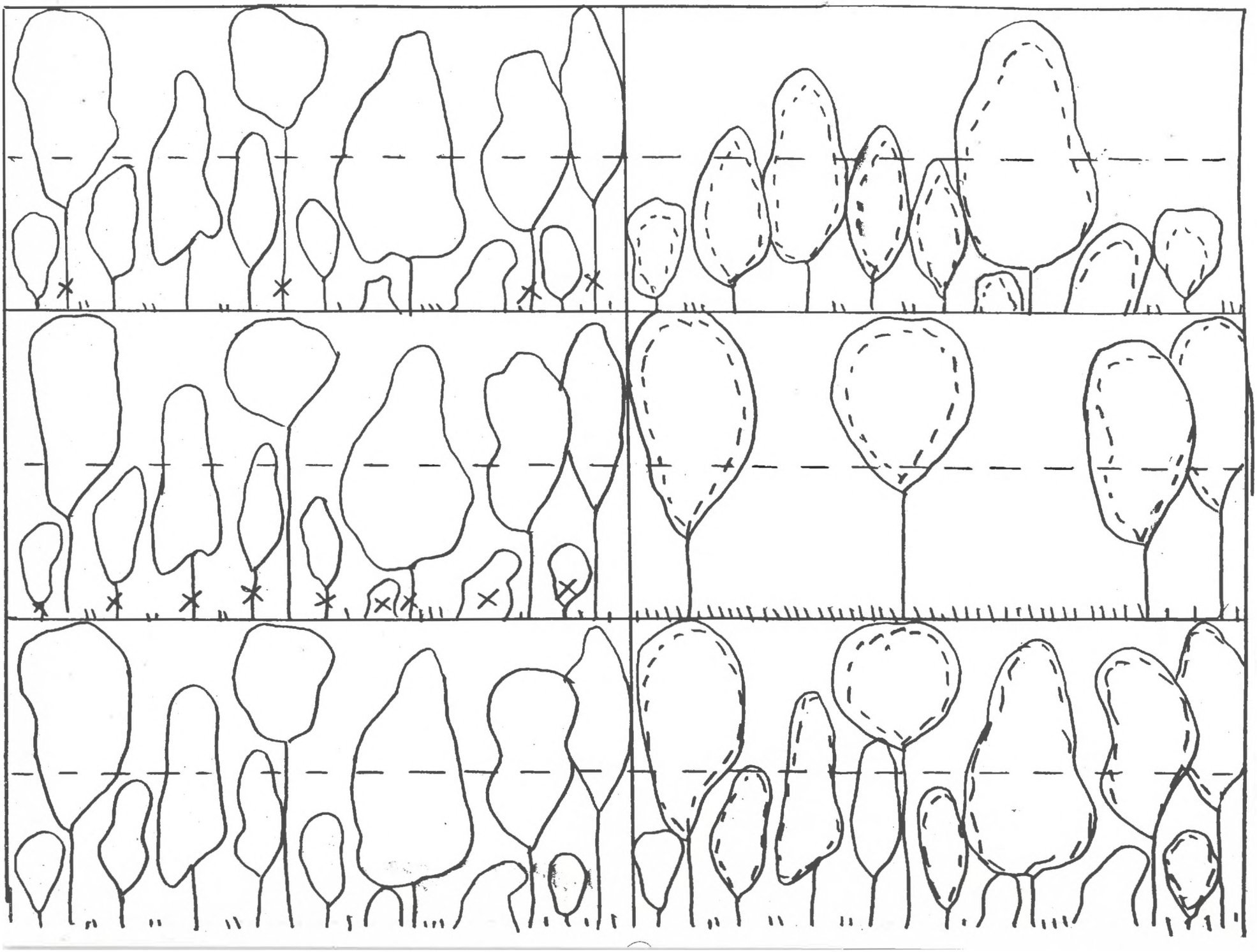
VII - Block 7
A - upper ⅓ of crown removed
B - lower ⅓ of crown removed
C - control (none of crown removed)
D - site burned
E - site scarified
F - control (site untreated)
. - square meter sampling plots

Figure 1. Arrangement of cultural treatment, site treatment and sampling plots within a ground cover study block.

trees or shrubs to be removed, and small vertical lines indicate anticipated ground cover plant growth.

At time of treatment

Three Years after treatment



Site treatments, originally scheduled for 1962, had to be postponed until 1963 because of difficulty in accomplishing the burning. Scarification was done with fire rakes in late summer, and burning in late fall. The burns were accomplished by igniting the piles of dried, solid fuel (wood), which had been protected from precipitation by covering with plastic tarpaulins.

After treatment, half of the site treatment plots (36) were fenced to exclude deer. This was done to prevent damage to vegetation that might mask the potential effects of the treatments.

Post-treatment Tallies of Vegetation: The same procedure described under Pre-treatment Tallies was employed in the post-treatment tally. Crown profile diagrams were made in 1964, and the plots tallied in 1965.

Summarization and Analysis of Data: Due to the great variation found in the vegetation, the split-plot analysis of variance originally planned was abandoned, and simpler, but coarser statistics employed. Where changes were tremendous, only totals, percentages, and means were used but where results of the pre and post-treatments tallies were close, 95 percent confidence intervals were used also. The details of the analyses used are given below under Findings.

Detailed analyses were restricted to abundant species. For non-woody ground cover, woodsorrel (Oxalis montana) and woodfern (Dryopteris marginalis) were chosen. The former is susceptible to 2-4-5-T, while the latter is resistant. Sugar maple (Acer saccharum) was used for analysis in the northern hardwood forest, yellow birch (Betula alleghaniensis) in the mixed growth type.

Findings:

1. The distribution of ground cover plants in both forest types is extremely variable, and largely prohibits the effective use of standard-size sampling plots to obtain data for statistical analysis.

2. There are more stems of non-woody ground cover plants in the hardwood-conifer forest than in the northern hardwood type. The total difference, however, is largely attributable to one species, woodsorrel, which is much more abundant in the mixed-growth forest. This general relationship holds for both the undisturbed and disturbed conditions (Table 1).

3. There is approximately an equal diversity of abundant non-woody ground cover plants in each forest type prior to disturbance, but after treatment the net loss in species is somewhat greater in the hardwood forest then in the mixed-growth type (Table 2).

4. More stems of woody ground cover are found in both the undisturbed and disturbed hardwood forest, then in either the

undisturbed or disturbed mixed-growth forest. These differences are largely attributable to sugar maple, which occurs in great abundance in the hardwood type (Table 3).

5. All combinations of treatments involving either burning or scarification reduced non-woody ground cover tremendously. This is evident from examination of the changes in both woodsorrel and woodfern in both forest types (Tables 4 and 5).

In the mixed-growth forest over 20,000 stems of woodsorrel were tallied on plots slated for burning and scarification, and but 705 stems after treatment. Comparable figures for woodfern are 1178 and 88. Control plots, on the other hand, changed relatively little. Examination of the means and 95 percent confidence intervals for woodsorrel on the control plots indicates that 10 of 12 plots were not significantly changed, while two decreased. For woodfern, none of the 12 plots changed significantly. While statistical differences are not evident, this may be the result of the coarse method of analysis imposed upon us by the unexpected, and extreme variability of the data. Thus, a consistent and marked increase occurred in both woodsorrel and woodfern on all plots involving upper crown removal and site control.

In the northern hardwood forest the low abundance and poor distribution of non-woody ground cover plants prohibited even a meaningful inspection of confidence intervals. Examination of the means alone, however, shows the same trend for woodsorrel and woodfern as in the mixed-growth type. Thus, again, the only treatment with a consistently positive effect was the upper crown removal combined with site control.

Most other non-woody ground cover species responded in a manner similar to woodsorrel and woodfern, although the magnitude of the reduction in overall numbers was often less. When all species are considered together, again, only the upper crown removal combined with site control produced consistent increases.

6. The effect of the treatments on woody ground cover (tree seedlings) was strikingly different from the effect on the non-woody cover.

In the hardwood forest, where sugar maple seedlings predominate, no pronounced effects of burning, scarification, upper crown removal, lower crown removal, control, or any combinations thereof was observed. Inspection of means and confidence intervals showed relatively little change, and no consistent trends. Overall figures yielded an estimate of 19,516 seedlings to the acre before treatment, and 15,103 per acre after treatment. The difference is probably attributable to differences in the magnitude of the two different seed years involved, but both densities are clearly adequate for silvicultural purposes. Apparently sugar maple seed is very abundant (periodically) and fairly

well-distributed, and has the ability to germinate as well on burns or scarified ground as on the undisturbed forest floor.

Conversely, woody ground cover was influenced greatly by the treatments in the mixed-growth forest, where all treatment involving crown disturbance and burning or scarification resulted in large increases, principally in yellow birch (Table 6). Examination of the means of these combined treatments shows increases in all 16 plots. Confidence intervals indicate that 14 of these 16 increases are statistically significant at the 5 percent level. The favorable effect of burning and scarification on yellow birch reproduction is also evident in the crown control plots, where five of eight plots showed significant increases. Differences between burning and scarification were not significant. Site control plots showed variable results, with little overall change evident.

While differences in the increase of birch seedlings between the upper and lower crown treatments were not consistent, the lower crown removal seemed slightly more effective in increasing the species.

Prior to treatment, only one study area contained enough yellow birch to permit the calculation of an aerial density figure. This showed 2794 stems to the acre. Other areas had essentially no seedlings present. After treatment, the overall figure for all plots rose to 5988 per acre, while the figure for the burned and scarified plots was 8855 per acre. These densities may be considered adequate for silvicultural purposes.

7. Projections of these results to potential management situations indicates that non-woody ground cover will be favored by cutting systems which increase light, but do not disturb the ground, ie., winter logging. In the mixed-growth forest, tree reproduction (mainly yellow birch), conversely, will be greatly favored by summer logging which does disturb the ground. On small areas at least, intensive burning can produce the same result. In the hardwood forest, sugar maple reproduction can and will occur under winter or summer logging, or, in the complete absence of disturbance.

8. From the ecological standpoint, it appears that while the setting-back of succession may be readily accomplished on small areas within the forest, the setback will be short-lived. Generally, the species which volunteer on the burned and scarified sites are those of the climax, ie., sugar maple and yellow birch. While some pioneers, eg., willows (Salix spp), aspen (Populus tremuloides), and Prunus sp. do occur on the burns, they are relatively few in numbers. Accordingly, succession on these small disturbed areas will probably approach the climax association rapidly.

9. Due principally to the early stage of development of vegetation on the treatments, little difference was found between the fenced and unfenced plots. As the tree reproduction develops, however, there should be an excellent opportunity to observe the evaluation of sugar maple and yellow birch from the new seedling stage through subsequent stages of development. Meaningful quantitative comparisons of the fenced and unfenced plots in the future should provide valuable basic information on what may be expected from a known number of seedlings, both in the presence and absence of browsing by deer.

Recommendations: This report should be considered as final for the phase of the study dealing with the initial response of the vegetative treatments. The survival and development of the plants which are now established on the treatments should be followed, and report submitted as warranted by changes in the vegetation.

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Table 1. Comparison of number of stems of abundant non-woody ground cover species in the northern hardwood and hardwood-conifer types before[1] and after treatment.

	Number of Stems					
	Northern Hardwood		Hardwood-Conifer		Total	
Species	Before	After	Before	After	Before	After
Woodsorrel	7659	3649	36409	11775	44068	15424
Shining Club Moss	654	364	3641	704	4295	1068
Spinulose Woodfern	1098	532	1876	1321	2974	1853
Canada Mayflower	138	16	1968	751	2106	767
Viola spp.	1644	1510	110	129	1754	1639
Foamflower	926	210	0	0	926	210
Goldthread	0	0	605	236	605	236
Jack-in-the-Pulpit	388	99	1	5	389	104
Common Club Moss	281	209	0	0	281	209
Indian Cucumber	98	0	133	0	231	0
Dwarf Raspberry	207	0	14	0	221	0
Bellwort	68	39	84	69	152	108
Starflower	7	0	95	410	102	410
Yellow Clintonia	2	0	99	1	101	1
Dwarf Dogwood	0	0	100	0	100	0
Total	13170	6628	45135	15401	58305	22029

1. The before treatment figures have been corrected since previous reports were submitted, but the corrections do not alter any of the findings reported previously.

Table 2. Comparison of relative abundance of numbers of species of non-woody ground cover plants in the northern hardwood and hardwood-conifer types before and after treatment.

Relative Abundance	Number of Species			
	Northern Hardwood[1]		Hardwood-Conifer[2]	
	Before	After	Before	After
Total Number Present	30	28	30	29
10 or more stems	19	17	21	13
20 " " "	16	13	16	11
30	16	13	14	11
40	13	11	13	11
50	12	10	12	9
100	9	6	8	7
200	8	6	5	6
500	5	3	5	4
1000	3	2	4	2
1500	2	2	4	1
2000	1	1	2	1
5000	1	0	1	1
10000	0	0	1	1

1. Following the treatments six species were gained, 11 lost, for a net loss of five.

2. Following the treatments seven species were gained, nine lost, for a net loss of two.

Table 3. Comparison of number of stems of abundant woody ground cover (ground-6") in the northern hardwood and hardwood-conifer types before and after treatment.

	Number of Stems					
	Northern Hardwood		Hardwood-Conifer		Total	
Species	Before	After	Before	After	Before	After
Sugar Maple	15806	12063	3041	1741	18847	13804
Yellow Birch	1939	954	591	4806	2530	5760
Red Maple	201	387	1033	1741	1234	2128
Beech	430	933	271	633	701	1566
Witch-hobble	217	44	479	131	696	175
Red Spruce	18	15	161	233	179	248
Balsam Fir	48	0	87	0	135	0
Striped Maple	43	77	37	19	80	96
Red Raspberry	42	62	35	243	77	305
Total	18744	14535	5735	9547	24479	24082

Table 4. Comparison of number of stems of woodsorrel and woodfern from pre-treatment[1] to post-treatment conditions, by treatment combination, in the hardwood-conifer type.

Treatment Cultural-site	Number of Stems			
	Woodsorrel		Woodfern	
	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
Upper Crown-burn	4053	31	210	2
Upper Crown-scarify	3315	247	198	34
Upper Crown-control	2640	5254	116	618
Lower Crown-burn	2543	28	142	0
Lower Crown-scarify	4016	112	222	21
Lower Crown-control	7508	2717	235	277
Control Crown-burn	1985	30	205	0
Control Crown-scarify	4936	257	206	31
Control Crown-control	5413	3099	342	338
Total	36409	11775	1876	1321

1. The before treatment figures have been corrected since previous reports were submitted, but the corrections do not alter any of the findings reported previously.

Table 5. Comparison of number of stems of woodsorrel and woodfern from pre-treatment[1] to post-treatment conditions, by treatment combination, in the northern hardwood type.

Treatment	Number of Stems			
	Woodsorrel		Woodfern	
Cultural-site	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
Upper Crown-burn	532	4	121	0
Upper Crown-scarify	663	154	91	0
Upper Crown-control	1292	2706	76	178
Lower Crown-burn	344	0	175	2
Lower Crown-scarify	1153	0	202	10
Lower Crown-control	2575	492	247	261
Control Crown-burn	339	0	50	0
Control Crown-scarify	310	16	70	3
Control Crown-control	451	277	66	78
tal	7659	3649	1098	532

1. The before treatment figures have been corrected since previous reports were submitted, but the corrections do not alter any of the findings reported previously.

Table 6. Comparison of numbers of stems of yellow birch (0-6") from pre-treatment to post-treatment conditions, by treatment combinations, in the hardwood-conifer type.

Treatment	Number of Stems	
Cultural-site	Pre-treatment	Post-treatment
Upper Crown-burn	115	299
Upper Crown-scarify	34	661
Upper Crown-control	9	28
Lower Crown-burn	77	1250
Lower Crown-scarify	72	1672
Lower Crown-control	99	39
Control Crown-burn	66	507
Control Crown-scarify	54	348
Control Crown-control	65	2
Total	591	4806

Table 7. Common and scientific names of plants given in the text and tables.[1]

Non-woody Plants		Woody Plants	
Common Name	Scientific Name	Common Name	Scientific Name
Bellwort	Uvularia sessilifolia	Balsam Fir	Abies balsamea
Canada Mayflower	Maianthemum canadense	Beech	Fagus grandifolia
Common Club Moss	Lycopodium clavatum	Raspberry	Rubus spp.
Dwarf Dogwood	Cornus canadensis	Red Maple	Acer rubrum
Dwarf Raspberry	Rubus spp.	Striped Maple	Acer pensylvanicum
Foamflower	Tiarella cordifolia	Sugar Maple	Acer saccharum
Goldthread	Coptis groenlandica	Witch-hobble	Viburnum alnifolium
Indian Cucumber	Medeola virginiana	Yellow Birch[2]	Betula alleghaniensis
Jack-in-the-Pulpit	Arisaema triphyllum		
Shining Club Moss	Lycopodium lucidulum		
Spinulose Woodfern	Dryopteris spinulosa		
Starflower	Trientalis borealis		
Violet	Viola spp.		
Woodsorrel	Oxalis montana		
Yellow Clintonia	Clintonia borealis		

1. Names according to: Fernald, M.L., 1950. Grays manual of botany. American Book Co., New York.

2. According to: Harlow, W.M. and E.S. Harrar, 1958. Textbook of Dendrology. McGraw-Hill Book Co., Fourth Edition, 566 pp.